

# **Weaponization of Space: Understanding Strategic and Technological Inevitabilities**

**Thomas D. Bell, Lt Col, USAF**

**January 1999**

**Occasional Paper No. 6  
Center for Strategy and Technology  
Air War College**

Air University  
Maxwell Air Force Base

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>JAN 1999</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Weaponization of Space: Understanding Strategic and Technological Inevitabilities</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Air University Press Maxwell AFB, AL 36112-6615</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>37</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

**Weaponization Of Space:  
Understanding Strategic and Technological Inevitabilities**

by

Thomas D. Bell, Lt Col, USAF

January 1999

Occasional Paper No. 6

Center for Strategy and Technology

Air War College

Maxwell Air Force Base, Alabama

**Weaponization Of Space:  
Understanding Strategic and Technological Inevitabilities**

Thomas D. Bell, Lt Col, USAF

January 1999

The Occasional Papers series was established by the Center for Strategy and Technology as a forum for research on topics that reflect long-term strategic thinking about technology and its implications for U.S. national security. Copies of No. 6 and previous papers in this series are available from the Center for Strategy and Technology, Air War College, 325 Chennault Circle, Maxwell AFB, Montgomery, Alabama 36112. The fax number is (334) 953-1988; phone (334) 953-2384.

Occasional Paper No. 6

Center for Strategy and Technology

Air War College

Air University

Maxwell Air Force Base, Alabama 36112

The internet address for the Center for Strategy and Technology is:  
<http://www.au.af.mil/au/awc/awccsat.htm>

## Contents

	Page
Disclaimer	..... <i>i</i>
Author	..... <i>ii</i>
Preface	..... <i>iii</i>
Abstract	..... <i>iv</i>
I. Introduction	.....1
II. First Steps Toward Weaponizing Space	.....3
III. US Air Force Must Adapt to New Means of Strategic -Bombardment	.....7
IV. Conclusions and Recommendations	....17
Afterword	....19
Glossary	....20
Notes	....21
Bibliography	....24

**Disclaimer**

The views expressed in this publication are those of the author and do not reflect the official policy or position of the Department of Defense, the United States Government, or of the Air War College Center for Strategy and Technology.

## **The Author**

Lieutenant Colonel Thomas D. Bell, USAF, has been involved in USAF fighter aviation for the majority of his 18 year career. After finishing pilot training in 1979, Lieutenant Colonel Bell served as an F-111 pilot, then an instructor pilot and weapons officer both in Europe and in the United States from 1980 until 1988. From 1988 until 1990 Lieutenant Colonel Bell was a staff officer in the weapons and tactics division at Headquarters Tactical Air Command. Following intermediate service school Lieutenant Colonel Bell qualified as an F-117 pilot and an instructor pilot with responsibilities for F-117 contingency planning, weapons and tactics, and training. Prior to entering the Air War College, Lieutenant Colonel Bell served as Commander, Detachment 1, 57th Wing. In this capacity, Lieutenant Colonel Bell was responsible for the conduct of follow-on operational test and evaluation and tactics development and evaluation for the F-117 "Stealth Fighter." Lieutenant Colonel Bell is a graduate of the United States Air Force Academy with a Bachelors Degree in Computer Science. His military education also includes graduation from the USAF Fighter Weapons School, Squadron Officers School, and the US Army Command and General Staff College. His civilian education includes a Masters of Science Degree in Computer Science from the University of Idaho. A 1997 graduate of the Air War College, Lieutenant Colonel Bell completed this research under the auspices of the Center.

## **Preface**

This study focuses on the question of the relevance of aerospace power beyond the twentieth century. My purpose is to generate a debate about whether it is inevitable that we will weaponize space and the role of the United States Air Force in this transition. My premise is that in order for the Air Force to keep its place as the nation's premier provider of aerospace power, it must not just participate in this process—it must lead the rest of the nation to this destiny. Operationally, we have not yet started to walk down this path. However, many of the technologies that will form the basis of the first weapons we will use in this environment are in development today. To ensure that the United States develops the combat capability that the nation needs, it is essential to develop the strategy and doctrine under which future Air Force warriors will employ these weapons. Otherwise, the technology we develop may not meet the strategic needs of the United States, and equally in the next war the United States may not have the technological asymmetry on which it has relied for victory since World War II.

The reader is encouraged to consider the position of the aviator in 1920, who was looking at the promise that aviation could provide strategic airpower for the nation. While keeping in mind the potential of strategic airpower to strike at the heart of the enemy, the reader should leave behind any personal prejudices as to the means for employing that power. This is not a discussion about bombers, or fighters, or missiles, or unmanned combat air vehicles. It is a discussion about what we as an Air Force need to do now in order to provide aerospace power to our nation as we approach the middle of the next century.

I would like to thank Dr. William C. Martel of the Air War College faculty and Colonel Theodore C. Hailes, USAF (Ret.) for their support and encouragement as I struggled with the ideas in this study. That being said, I alone am responsible for any inadequacies in this paper.

## **Abstract**

It is inevitable that mankind will weaponize space and equally likely that this will take place in the next thirty years. The United States is in the early stages of a transition from using space assets to support combat operations on the surface of the earth to using space assets to conduct combat operations in space, from space, and through space. This paper discusses factors driving the United States to take its first steps to weaponize space. It is time for the Air Force to build the doctrinal framework for combat operations in, from, and through space that will guide the technological development of space assets just as the doctrine of strategic bombardment guided Air Force thought and aircraft development prior to World War II. This paper discusses the transition from an air to a space force by examining required changes to Air Force doctrine in terms of the framework of its six core competencies in order to prepare the Air Force to organize, train, and equip aerospace forces for conducting combat operations in space.

## I. Introduction

More than seventy-five years have passed since the guns fell silent in the Meuse-Argonne. Before the ink was dry on the German surrender in the rail car at Compiegne,<sup>1</sup> historians were busy sorting out what had happened and why. Many were trying to assess how various forms of warfare broke the stalemate of the trenches and helped the Allies achieve ultimate victory over Germany.

Historians saw the triumph of land warfare. They noted the impact of technological advances, such as the tank, in restoring maneuver to the battlefield. The creation of this technical asymmetry was vital in overcoming the horrors of trench warfare. Historians also noted, in many cases parenthetically, the role of air power.<sup>2</sup>

Air power advocates, on the other hand, believed that the First World War validated the accomplishments of their fledgling systems and provided a vision of what air power could become. As a spotter for field artillery, air power was “a decisive factor in creating and maintaining the stalemate.”<sup>3</sup> The fighter plane developed “according to the needs of battle, rather than according to a doctrine or in some deliberately chosen direction.”<sup>4</sup> In an escort role, it contributed to the defensive lull. In the pursuit role, it facilitated the offense.<sup>5</sup>

However, “[only] strategic air power seemed to offer a real alternative to the bloody, indecisive collisions along a static front: the swift, deep, surgically precise stroke at just the right objective what Clausewitz called the enemy's center of gravity that would ensure his rapid collapse.”<sup>6</sup> This strategic air power doctrine or vision of what air power could become served as the framework for air power theorists and technological developments throughout the inter-war period.

More than five years have passed since the guns fell silent along the Iraqi “highway of death.” Before the ink was dry on the Iraqi cease-fire in the tent at Safwan,<sup>7</sup> historians were busy sorting out what had happened and why. Many were trying to assess how various forms of warfare helped the coalition achieve ultimate victory over the Iraqi army and the liberation of Kuwait.

Historians saw the triumph of joint and coalition warfare led by a decisive air campaign. They noted the impact of technological advances, such as stealth aircraft and precision guided munitions, in destroying the Iraqi command and control structure and removing the Iraqi capability to maneuver on the battlefield. The use of the existing technical asymmetry was vital in overcoming the potential horrors of fortified Iraqi defensive positions. Historians also noted, in many cases almost parenthetically, the role of space power. The index of the Air Force official history of the Gulf War, *The Gulf War Air Power Survey Summary Report*, addresses space assets on only one page.<sup>8</sup> The index does not make reference to the United States Space Command (USSPACECOM). Like air power in the First World War, space power in the Gulf War appeared as an auxiliary, that supported the main action; it was not itself at center stage. Space power advocates, on the other hand, argued that the Gulf War validated the accomplishments of their satellite systems. The Global Positioning System (GPS) was critical to the conduct of the war, despite the fact that it was not yet an operational system; only 16 of the 21 then planned satellites were in orbit.<sup>9</sup> Coalition forces in the Gulf used over 12,000 hand-held GPS receivers.<sup>10</sup> Six Defense Meteorological Satellite Program satellites furnished high-resolution, near-real time meteorological information in the midst of the worst weather in the

Persian Gulf in fourteen years.<sup>11</sup> Defense Satellite Communications System satellites provided in-theater and inter-theater secure communication. Three Defense Support Program satellites “scanned for and reported bright infrared ‘events’ the exhaust glow from Scud launches. Two civilian satellites systems also provided imagery: the US LANDSAT and the French SPOT [Système Probatoire d’Observation de la Terre].”<sup>12</sup> Like their air-breathing counterparts at the end of World War I, space power advocates left the Gulf War with a vision of what their systems could provide to the nation given the technology and the political will to turn the vision into reality.

This essay examines that vision of space power and its implications for the weaponization of space in the twenty-first century.<sup>13</sup> It argues that it is inevitable mankind will weaponize space, and equally likely that this weaponization will occur with maturing of specific technologies over the next thirty years.<sup>14</sup> U.S. planning for military operations is in the transitional stage from relying on space assets to support combat operations on the surface of the earth to depending on space assets for the conduct of combat operations in, from, and through space. The US ability to conduct combat operations in this environment will provide the technical asymmetry that the US will need to win the next war, just as it used strategic bombers and the atomic bomb to win World War II and stealth technology and precision guided munitions to win the Gulf War.

To make this transition, the US must overcome current legal and political impediments to doing so.<sup>15</sup> It is assumed that the political will to weaponize space will lead to overcoming these obstacles. In addition to these hurdles, the USAF must overcome certain technical obstacles to make military operations from space a reality. The Air Force Scientific Advisory Board's report, *New World Vistas: Air and Space Power for the 21st Century*,<sup>16</sup> outlines in great detail the technologies necessary to accomplish this objective.

Perhaps most difficult of all, the Air Force must overcome institutional and doctrinal impediments to start building the doctrinal framework for space combat operations that will guide the technological development of space assets in much the same way as the doctrine of daylight precision bombardment guided Air Force thought and aircraft development prior to World War II. The Air Force's six core competencies provide the framework for analyzing how the Air Force as an institution must change the way it organizes, trains, and equips aerospace forces to conduct combat operations in the space environment. First, however, it is necessary to consider what will drive the United States to take the first steps to weaponize space.

## II. First Steps Toward Weaponizing Space

Just as the role of US military operations in space has gradually shifted from scientific interest, through intelligence collection, to robust combat support, so it will continue to shift inevitably toward the weaponization of space. In discussing the expanding role of the military in space, the term weaponization implies an increase in the capability to conduct warfare in, from, or through space. It is appropriate to use the term weaponization, rather than militarization, because both the United States and Russia have already militarized space. Since man's earliest days in space, intelligence and communications satellites have had military missions. While space has not been weaponized yet, there are historical reasons for suspecting that the weaponization of space is as inevitable as was the weaponization of the land, sea, and air media of warfare. The results from these cases show that, although the initial involvement in the land, sea, and air media was not for military purposes, the militarization and ultimate weaponization of each medium occurred because of the belief that it was necessary to protect resources in these environments. It is for this reason that the causes for the weaponization of these media are relevant to space.

### Selected Examples

The development of combat forces on land predates recorded history. As people acquired more resources to protect, the need for land forces increased, and with that development societies turned toward citizen-soldiers for protection. The history of the militarization of land is the history of civilization itself. As civilization advanced, so too did its resources and the nature of the armies which guarded their security.

As with armies, the development of navies precedes recorded history. By 1100 BC the Phoenicians were the dominant maritime traders in the ancient world. Their navies sailed the Mediterranean to protect Phoenician commerce. In 404 BC, Athens was the preeminent naval power in the Mediterranean given that the need to protect the maritime empire dominated the economy of the Aegean. But it was Sparta's ability to change its traditional land power strategy and to use the navy to project power that led to the ultimate defeat of the Athenian army in Sicily in the third phase of the Peloponnesian War.

The same trends continued in more modern times. As with land forces, the need to protect vulnerable resources led to the development of navies. As the resource needing protection moved further from home, the ability to project power against the enemy also increased. Culminating in a centuries old desire to fly, the Wright Brothers invaded the sanctity of the air with powered flight in 1903. Within six years, they had signed a \$30,000 contract with the US government to produce biplanes for the Army.<sup>17</sup> The weaponization of the air had begun. Early attempts at the weaponization of the air were unsuccessful. Winchester rifles strapped to the struts of 1st Aero Squadron aircraft in Mexico proved inadequate.<sup>18</sup>

Even at the beginning of World War I, the weaponization of the air was not complete. "The relationship of opposing pilots of observation aircraft was quite friendly at first. As they crossed the front lines each morning, German and French pilots usually waved and returned friendly smiles. This, however, did not last long. As the fighting dragged on . . . more and more aerial incidents took place as bricks were thrown and a few shots from hand guns exchanged.

Hand dropped bombs were developed, making the airplane a real offensive weapon.”<sup>19</sup> By the end of the war, opposing forces expanded the weaponization of aircraft to include machine guns firing through the propeller arc.

## **Weaponizing Space**

The oceans are a vast but finite resource. Due to the locations of the continents and the nature of commerce between trading partners, some portions of the oceans are busier than others. The result is competition for limited resources and an opportunity to control the seas by controlling the chokepoints. Space, as currently used, is also a finite resource. The view space provides and the capability to pass information through space at the speed of light from one point to another on the surface of the earth makes certain satellite orbits more valuable, and hence busier than others. This leads to chokepoints in space.<sup>20</sup> As in the case of the sea, the result is competition, and with competition will emerge conflicts; and from those conflicts, it will be necessary for societies to control space.

The United States is extremely dependent on space assets.<sup>21</sup> The average US citizen depends on space assets each day for telephone communications, cable television, weather forecasts, and other information. American business is increasingly reliant on satellites for information transfer, to locate natural resources, to plot maps, to measure growth, etc. The number of business uses for space will only increase over the coming decades. The plan for business consortia such as Iridium and Teledesic to orbit satellite constellations (providing world-wide cellular phone and internet access via satellite) will inextricably link daily activities of businesses and ordinary citizens with space assets. With every day that passes, the political and economic system in the United States becomes even more reliant on the assured connectivity that space resources provide.

The United States military is no less dependent on space assets. Key intelligence, surveillance and reconnaissance, strategic and theater level warning, weapon's guidance, communications, command and control, and environmental monitoring functions are migrating to space.<sup>22</sup>

As an increasing number of these critical resources and capabilities migrate to space, the need increases to protect these resources, in peace and war. As prehistoric peoples developed armies on land to protect their resources, as the Phoenicians developed navies to protect their trade routes in the Mediterranean, and as nations developed air forces to protect their resources from attacks in the third dimension, space will become an arena for military operations. Having been militarized virtually since the beginning of man's experience in this medium, societies will weaponize space as they perceive threats to the ability to gather information, communicate, and trade in, from, or through space. The question is not whether societies will do so, but when and in response to what stimulus.

Control of space is not only important to ensure access to satellites but to support military operations on the earth. Just as control of the air is a precursor to effective operations on the land or sea, control of space is a prerequisite to effective operations in all terrestrial media (land, sea, and the air). Any disruptions to military access to space could jeopardize American military activities as reliance on space assets is increasingly becoming a strategic center of gravity for the United States.

Recognizing that political and diplomatic alternatives will be limited if the United States does not control access to space, President Clinton's space policy “directs the nation to maintain

its pre-eminent position as the world's number one space power.”<sup>23</sup> The Commander-in Chief, US Space Command (USCINCSpace), is “tasked with the missions of space control and force application in support of the joint warfighter.”<sup>24</sup> As the former commander General Estes stated, “control and access to the benefits of space . . . must be maintained and protected. Even today, terrestrial land and sea operations can only be conducted successfully by those who control the air and space above the battlefield.”<sup>25</sup> These comments show the increasing importance of assured access to space to the security of the United States, as well as the increasing willingness of national leaders to discuss the weaponization of space.

## **Is Now the Time?**

It is clear that societies will weaponize space as an increasing number of high-value resources in the form of commercial and military systems migrate to space. The questions that remain are whether now is the time to begin the inevitable weaponization of space; whether to protect space given its increasing importance to the United States, whether the US should be the first nation to do so; and finally the implications for the United States Air Force of this weaponization.

During the twentieth century, both to reduce the cost of maintaining large standing armies and to protect human life in battle, the US turned to technological superiority as the basis for success in warfare. In World War II, long range bombers, carrier aviation, and the atomic bomb provided the technological edge required for the defeat of the Third Reich and the Japanese Empire. Arguably, in Korea and Vietnam, technological superiority was present even if the will to use it was not. In the Persian Gulf War, the United States gained a decisive advantage through its ability to apply technological superiority. Whether measured in terms of space assets, air refueling, precision guided munitions, or stealth, coalition forces led by the United States fought the war on a different technological level than their Iraqi opponents. This technological asymmetry allowed the United States to fight a short war with minimal casualties.

Technological asymmetry provides another advantage. It allows the United States to control crisis escalation. With technological superiority, America can threaten to escalate to prevent an unwanted turn of events (e.g., threaten to escalate to nuclear war against a non-nuclear adversary in response to a chemical attack). The United States never wants to fight a war from a position of technological parity or inferiority. To do so may well shift escalation dominance to the enemy, especially if that enemy is unconstrained by public opinion.

The problem with technological superiority, however, is that it is never constant and never guaranteed. American forces were not the only ones to learn lessons from the Gulf War. Potential future adversaries also watched and learned. They saw the success of a well-led coalition that employed air refueling, precision guided munitions, stealth, and uncontested access to space assets. No doubt future adversaries are trying to develop their capabilities in these areas as well as develop countermeasures to reduce US effectiveness.

The United States cannot hope to fight another war with the same technology and achieve the same level of success as in 1991. The US must never again plan to face an adversary who does not contest its ability to use information gained from space assets. The playing field has once again changed and the US military must also change in order to defeat the next enemy.

The weaponization of space provides the asymmetric technology the US needs to win the next war. The United States is the only nation with the economic and scientific potential to make this technology a reality in the next thirty years. The technological development of weapons that

apply force in, from, and through space must have the goal of fielding weapons as the technology matures. Just as the doctrine of daylight precision bombing guided the development of the long-range bombers of World War II, today's Air Force must develop doctrine for the employment of space weapons. This space version of strategic bombardment doctrine will serve both as a guide to technological development and as a plan for the long-term structure of the Air Force. If no war comes, US space-based capabilities will have proven an effective deterrent force; if war does come, as the inevitable result of competition on earth or in space, technological asymmetry will once again be a large factor in giving the United States the capability for winning a decisive victory. To be effective, however, institutional and doctrinal change must accompany this technological asymmetry.

### III. US Air Force Must Adapt to New Means of Strategic Bombardment

Large bureaucracies are notoriously slow to change. The government is probably the slowest of these large bureaucracies, because unlike a corporation facing major change, it has no profit motive.<sup>26</sup> These large bureaucracies are also slow to divest themselves of portions of the organization which are no longer relevant to their operations in a new environment. As Major General (Retired) Perry M. Smith said in his book, *Taking Charge*: “[in] government, divestiture is a more difficult process because the obsolete areas are harder to identify and more difficult to exorcise from the organization.”<sup>27</sup> In making the transition to weaponize space, the Air Force may find that the most difficult impediments to be overcome are those internal to the Air Force itself.

Crossing the bridge to allow combat operations in space will be a difficult decision for the Air Force, both because of the new method of warfighting it creates and because those new methods will, at some point, replace old ones which have been the foundation of the institution since its inception. The change may not be immediate, but once the threshold is crossed, there will be no going back. Just as there are no longer any knights in shining armor or cavalry soldiers on horseback, one day there will no longer be bomber or fighter pilots. However, unlike the disappearance of these older forms of warfare, the decision that the time is right to move from an air force to a space force will likely be made by Air Force leaders who grew up in the organization, living and breathing the types of fighter and bomber aviation which space warfare will ultimately replace. The more important point, however, is that the Air Force needs to eliminate such military systems before these become obsolete.

Making the transition to military operations in space will take fortitude, vision, and, most of all, timing. The fortitude will be derived from the need to shift from a means of applying air power that has matured since the promise of aviation first showed itself in World War I and one that arguably lived up to that promise in the Gulf War. It will require the vision to realize that in doing so, only the means of air power are changing. The ends, by which it is meant the capability to bypass the horrors of a prolonged ground war by immediately attacking the enemy's strategic center(s) of gravity, will not have changed; in fact, they will be enhanced by the new means of warfare.<sup>28</sup> The timing relates to making these decisions as the technology matures. If the United States decides too late, which occurs when the capability for space warfare is not available when needed, the Air Force would have to fight a war at this time without the technological asymmetry space offers and upon which the nation depends. By contrast, if the United States decides too early, there will be a gap in the capability to provide aerospace power today because the requisite space technologies will not have matured.

In the end, the question may not so much be whether the nation is ready to overcome the legal, economic, and political hurdles to conducting combat operations in space, but whether the Air Force is ready to give up fighter and bomber aviation and change its institutional mindset to meet the new strategy. As the nation's primary provider of air and space power, the Air Force must adapt to the strategic needs that space warfare will bring to the nation. To examine these changes the reader must assess the strategic setting in which the Air Force will operate, the Chief of Staff's strategic vision for the Air Force in the twenty-first century, and the need for a comprehensive Air Force doctrine to guide the development of technology to meet this future reality.

## Twenty-first Century Politics

The breakup of the Soviet block significantly altered the international scene. In place of the bipolar world that governed international relations from the start of the Cold War until 1989, the United States now finds itself in a unipolar world. This world, characterized by an unclear threat and a regional, rather than global focus, is not necessarily more stable than the bipolar world of the Cold War era. In places such as Yugoslavia, Africa, and the Middle East, the world has seen the reemergence of centuries old hostilities, no longer held in abeyance due to the overriding concerns of superpower confrontation. The peace dividend, so ardently hoped for at the beginning of the decade, has yet to emerge.

President Clinton's national strategy calls for the United States to engage with other nations in an effort to "enlarge the community of . . . democratic nations."<sup>29</sup> Government agencies support the national strategy by using various instruments of national power to build regional partnerships with democratic and emerging democratic nations around the world. The national military strategy supports the national security strategy through the use of the military instrument of national power. As currently structured, the national military strategy is "a defensive strategy that will prevent, that will deter, or that will defeat any adversary who threatens [the United States or its] allies."<sup>30</sup> Increasingly, this strategy is based on the employment of a continental United States (CONUS) based contingency force since many of the forces deployed overseas during the Cold War have been brought home or demobilized.<sup>31</sup>

In 1996, General John M. Shalikashvili, the Chairman of the Joint Chiefs of Staff, published his vision for the United States military as it enters the first decade of the twenty first century. The document "Joint Vision 2010" provides a roadmap for the US military to follow in meeting the strategic challenges the military will face in this timeframe. In articulating his vision, Shalikashvili outlined four key operational concepts that US military forces must possess in order to accomplish their objectives in light of the expected future threat and strategic setting. These are dominant maneuver, precision engagement, full dimensional protection, and focused logistics.<sup>32</sup>

## A New Strategic Vision

The Air Force is following Shalikashvili's lead in adapting to the needs of this new strategic setting. Through the document *Global Engagement*, the Air Force identifies the ways in which it intends to meet the problems of tomorrow's strategic environment. Dr. Sheila Widnall, the former Secretary of the Air Force, recently identified these problems as globalization, international competition, proliferation of weapons of mass destruction, and doing more with less.<sup>33</sup> To meet the vision of *Global Engagement*, the Air Force must "renew and invigorate its core vision of aerospace power."<sup>34</sup> Through a revitalization process, the Air Force hopes to create for itself a "unified, coherent, compelling, vision of aerospace power"<sup>35</sup> which will guide the employment of strategic aerospace power in the 21st century.<sup>36</sup>

*Global Engagement* defines the Air Force's new core competencies as the link between doctrine and the acquisition process. It is more appropriate, however, to think of doctrine as the bridge between the core competencies and the acquisition process. Joint Publication 1-02 defines doctrine as "[fundamental] principles by which the military forces . . . guide their actions in support of national objectives."<sup>37</sup> The core competencies outline those skills that the Air Force

must possess in order to support the commander in the joint battlespace of the future. The acquisition process, quite simply, provides the tools with which Air Force members accomplish those tasks. In essence, a viable service doctrine forms the bridge between the delineated core competencies (what the Air Force must do) and the acquisition process (the means for getting the tools to do it). The absence of a viable doctrine weakens the linkage between the tasks and the means for accomplishing those tasks.

To put this in perspective, it is once again appropriate to reflect upon the historical example provided in the years prior to World War II. Airmen came out of World War I with the vision that air power could take the war to the heart of the enemy nation without first fighting through the enemy army in the field. The core competency of strategic bombardment was developed as an avenue to avoid a repeat of the carnage of the trenches. The doctrine these airmen developed called for daylight precision bombing as the means to accomplish the objective of strategic bombardment. This doctrine guided the development of the B-17 and the Norden bombsight as the technological means for accomplishing that objective.

The problem today is that even with the development of such technologies as the ground-based lasers, space-based lasers, and kinetic energy weapons that are discussed in *New World Vistas*, there is no space doctrine to form a bridge between the core competencies and the acquisition process. Now is the time to develop space doctrine for the twenty first century. Rather than being too early to think about this problem, it is imperative that the Air Force expand its doctrine to provide the connecting link between the scientists and engineers who are currently developing the requisite space technologies and the operators who will one day employ them in combat. If done correctly, the development of this doctrine will result in a fighting force better organized, trained, and equipped to perform its mission.

## **A Doctrine to Meet Future Challenges**

The significance of Global Engagement is the identification of the Air Force's six core competencies, which are brief statements of the major tasks in which the Air Force must be proficient if it is to successfully provide air and space power to the nation. Those competencies—information superiority, air and space superiority, global attack, precision engagement, agile combat support, and rapid global mobility—“represent the combination of professional knowledge, air power expertise, and technological know-how that, when applied, [produce] superior military capabilities.”<sup>38</sup>

Space will play an ever-increasing role in the way America projects military power in the twenty first century. To meet the nation's future needs through space, the Air Force must adapt to incorporate this new form of military operations into the way it organizes, trains, and equips the service. Viewing these changes through the framework of the six core competencies highlights how the very nature of the Air Force's most basic tasks must change to conduct warfare in, from, and through space. Doing so allows the Air Force to build a doctrinal bridge between the core competencies and the acquisition and programming process. It will also provide a reference for scientists and engineers in the development of applicable technologies to ensure that the products they field meet operational needs. Thus, the six core competencies provide a framework for understanding the doctrinal changes the Air Force must make in its transition to conducting military operations in space.

## **Information Superiority**

Information provides military commanders with a “comprehensive” picture of the battlespace. One of the coalition's largest advantages in the Gulf War was the information provided, in large part, by space assets. Coalition commanders made decisions based on information from space assets that were not available to Iraqi commanders or even the Iraqi national leadership.

Future adversaries will not allow the United States uncontested access to information from space assets. As a nation, the US is becoming more and more reliant on information technologies. The Air Force of the twenty-first century must be able to act in a defensive role to protect the nation's means of observing the enemy. It must be able to combine this information with other sources to deduce the enemy's capabilities and intentions, as well as make decisions based on the available information. And finally it must be able to carry out these decisions in a timely and militarily effective manner.

Offensively, the US must be able to deny this same capability to the enemy.<sup>39</sup> In recommending a space control strategy based on information dominance, rather than asset destruction, the “actual threat [to US interests] is the information space systems provide, not the space systems themselves.”<sup>40</sup> By controlling the flow of information to and from enemy satellites, the US could control the information on which future enemy commanders rely to make their strategic decisions. It is easy to envision the strategic advantage that the United States could gain in such a world.

To execute this strategy, information superiority must become the cornerstone of space warfare, and the emerging technologies that are developed must support the strategy of information dominance. Maintaining the capability to use our information technology, while denying a similar capability to the enemy, is the primary objective of any future space control campaign.

## **Air and Space Superiority**

The development of the doctrine for daylight precision bombing offers a lesson in the development of future space doctrine. One of the deepest convictions of daylight precision bombing doctrine was that once a well-planned and conducted attack was launched, it was unstoppable.<sup>41</sup> In other words, the proponents of daylight precision bombing believed that their bombers were invulnerable. This overriding belief in doctrine, when combined with the technological problems associated with building fighter aircraft in the 1930s with performance that could match a bomber's range and altitude capability, meant American bombers entered World War II without long-range fighter escort.<sup>42</sup> German fighters decimated the bombers. As many as 16 percent of the bombers dispatched on the Schweinfurt raid in August 1943 were lost.<sup>43</sup> These horrendous losses forced Allied leaders to recognize that air superiority was a prerequisite to strategic bombing.<sup>44</sup>

Those developing the technologies and doctrines to weaponize space should be alert to the problem that their predecessors confronted when they developed the doctrine for aircraft. Force projection satellites will need protection from enemy antisatellite (ASAT) systems. Whether protection occurs in the form of escort satellites or an ASAT system based on the

ground is not important from a doctrinal point of view. However, what is important is to learn from the mistakes of the past by never again sending force projection assets into harm's way without air and space superiority. Space control will be a prerequisite for power projection from space.

In the next 30 years, space superiority will join air superiority as the most important core competency as the Air Force mission expands to control the vertical component of a battlespace. Control of the air is currently a prerequisite for all of the force application, force enhancement, and force support missions that are conducted not only by the Air Force, but by the other military departments as well. Over the next 30 years, control of space will become an equally important prerequisite for projecting power on or above the surface of the earth.<sup>45</sup> As we enter this period of transition to military operations in space, it is evident that the military is behind in understanding how to exploit the opportunities of space to attain an operational advantage.

The advantages to the United States of operations in space are so significant that any future potential adversary will be obligated to target them. By the year 2000, roughly twenty nations will have access to space<sup>46</sup>. Space will not be a passive sanctuary in future conflicts, which means that the United States has no choice but to weaponize space. If the US goal is "to keep [its] own freedom of action in space while denying it to the enemy,"<sup>47</sup> the US must develop the capability to disrupt, destroy, deny, and degrade enemy space systems and ground based control systems.<sup>48</sup> To reach this goal, the United States must have the ability to accomplish three missions: space surveillance, space negation, and space protection.<sup>49</sup>

To enhance space surveillance, the US must develop and maintain the capability to observe each satellite throughout its entire orbit, which will give the United States knowledge of all enemy satellites. It is a short step from awareness to the ability for each US satellite to protect itself.

Second, the US must develop the capability to deny a potential enemy the use of its space assets. Limiting an adversary's access to space would be one way to accomplish this mission, while another method would be to deny the enemy the capability to control satellites in space. Yet another method would be to degrade an individual satellite's ability to sense the information the enemy tasks it to collect. The US must develop the capability to deny freedom of action to the enemy in each of these areas. Additionally, the Air Force should develop means to reverse the effects of at least some space denial weapons, including, for example, the capability to restore an enemy's satellites to their pre-conflict status.

Finally, the Air Force must develop the capability to protect US space assets from enemy attempts to control the space environment. This includes the physical protection of both those assets in space as well as those space systems that reside on the earth.<sup>50</sup>

Research must continue into technologies that can provide solutions to these strategic problems. Technologies recommended by the *New World Vistas* report including ASAT systems, space mines, uplink and downlink jammers, space decoys, and satellite signature reduction techniques may show promise over the next three decades.<sup>51</sup> Some of these technologies exist or are in development.

This section has primarily discussed the capability to control space and protect critical space control facilities on the earth. When reading the next section on global attack systems that provide the capability to attack strategic targets on the face of the earth from or through space, it is important to understand that these same technologies will eventually offer a capability to establish air superiority against aircraft. These space systems will provide a means to accomplish the offensive counterair, defensive counterair, and suppression of enemy air defenses mission

from space, and will reduce, if not eliminate, the need to deploy air-breathing air superiority assets to an operational theater of war.

## **Global Attack and Precision Engagement**

The ability to conduct global attacks means that the Air Force can attack targets rapidly with available munitions anywhere in the world. The concept of precision engagement implies that the desired level of force can be applied against a specific target without damaging nearby facilities. Combining these two core competencies is sensible because the trend toward precision engagement means that any application of force from space will be subject to restrictions to minimize collateral damage.

Force application from space will give a new meaning to responsiveness and lethality in global attack and precision engagement. It will revolutionize the way the United States projects military power because it will allow the application of force against any target on the face of the earth through space.<sup>52</sup> From a robust space-based laser system, or a ground-based system transiting space, the US will have the capability to conduct a strategic air campaign on the order of Desert Storm in a matter of minutes without the need for deploying forces.<sup>53</sup> By extension, the capability will also exist to conduct an interdiction campaign without the need to deploy forces.<sup>54</sup>

A functional capability to conduct space-to-earth targeting will require a synergy between intelligence and operations. In the future, space assets will bear an increased share of the responsibility for determining the location of targets. Once located and identified, military operators will be able to attack targets virtually instantaneously. For example, lasers can attack fixed targets at will, which means that mobile targets will essentially become fixed as the time between acquisition and firing approaches zero.

The laser system must have the capability to attack “short dwell” targets. These are defined as targets “that are vulnerable for a time short enough that their vulnerability is determined by the exposure time, rather than by characteristics of an attacking weapon.”<sup>55</sup> Targets such as mobile Scud or cruise missiles fall into this category. To achieve operational effectiveness, designers and operators must minimize the time between target acquisition and weapon firing. It may be necessary to develop algorithms for autonomous attacks against high-priority targets that have verifiable signatures in certain scenarios. This may involve taking human operators out of the firing loop against these fleeting targets once commanders make the decision to engage this type of target.

A mix of space weapons will offer the capability to destroy various types of surface and sub-surface targets with three types of weapons: continuous lasers that use heat to melt structures and destroy them;<sup>56</sup> pulsed lasers that vaporize material and penetrate the structure;<sup>57</sup> and kinetic energy weapons that provide the capability to attack targets hundreds of feet under the surface of the earth.<sup>58</sup> Radio frequency energy also provides interesting military capabilities. Although these are less mature than laser weapons, radio frequency weapons may well prove to be more valuable to the operational community.

The technologies required to develop these directed energy systems are reaching maturity. In some cases, the development of these capabilities exceeds initial projections.<sup>59</sup> While the technologies that are required to bring these capabilities to fruition are several decades away,<sup>60</sup> these ideas offer the greatest promise in reaching the goal of an instantaneous capability for conducting global attacks.

The fact that twenty-first century technologies will allow the Air Force to conduct strategic air and interdiction campaigns without deploying forces raises three collateral issues. First, the ability to conduct a strategic air or interdiction campaign without deploying forces raises questions about the need for overflight or basing rights. The corollary is that the United States will have an unparalleled degree of freedom in those cases when political constraints do not permit the formation of coalitions.

Second, if the Air Force does not need to deploy aircraft to conduct the strategic attack, interdiction, and air superiority missions, with the exception of heavy airlift, it is not clear what the function of aircraft in the force structure will be within several decades. Nor is it clear what the effect will be on logistics and basing.

Third, the Air Force must consider whether close air support (CAS) is still an Air Force mission. Attacks against fixed targets outside the ground commander's area of responsibility will be relatively simple to coordinate and execute from the continental United States.<sup>61</sup> It may, however, be more difficult to coordinate attacks from space against moving targets that are near friendly ground troops because this will raise concerns about the risk (whether real or perceived) of fratricide. Perhaps as the air superiority, strategic attack, and interdiction missions shift to space, close air support (if still conducted by aircraft assets) should revert to ground forces. Doing so would provide the ground commander with an integral fixed wing capability for providing firepower that supports the scheme of maneuver, and thereby relieve the Air Force of the need to deploy and sustain forces for close air support.

While working to develop offensive capabilities for applying force from space, the Air Force must not neglect a defensive capability against similar weapons. While it is broadly assumed that the United States will not face a peer competitor for the next twenty years, some of these technologies that could threaten the United States will not mature for at least that long. There will be a convergence between the rise of a peer competitor and the maturing of technologies that could threaten U.S. military dominance. It is true that “global presence with weapons capable of destroying or disabling anything that flies, in the air or in space, or anything on the ground or on the surface of the sea that is unprotected by armor, will drive a new warfare paradigm.”<sup>62</sup> It is also true that “in that new paradigm, the very weapons that drive it will become threatened by their own kind, and the eternal measure-countermeasure contest will be renewed with new dimensions of technology and tactics.”<sup>63</sup>

## **Agile Combat Support**

The participants at the Fall 1996 Corona conference added agile combat support as a separate Air Force core competency in order to emphasize the how important deployment and sustainment are to military operations.<sup>64</sup> The shift to conducting warfare from space will not only make major changes in the way that the Air Force conducts military operations, but it also will significantly alter the Air Force's support structure as well. The concepts of deployment, sustainment, and protection of aerospace forces will change as much as operational doctrine. The shift of warfare to space will dramatically lessen the need for military commanders to deploy forces overseas. Large deployment packages to the combat theater will not be necessary, because fewer (if any) fighter or bomber squadrons will deploy. At the same time, the ability to strike strategic targets from the US homeland will reduce the need to preposition or transport personnel and materiel to the theater. This will produce large savings in transportation costs because there will be less need to move bulky items to the theater, such as precision-guided

munitions, for striking strategic targets. There may be a reduction in the need to sustain forces given reductions in the number of personnel in the theater. All of this is consistent with the USAF view that we are well past the time when it is necessary to mass large amounts of material for overseas operations.

The Air Force will also be able to significantly decrease its peacetime logistics infrastructure with the shift to space warfare. The decrease in the number of fighter and bomber units will produce a commensurate decline in the need to support these forces. For example, the decrease in the number of Air Force aircraft, in conjunction with common spare parts on the remaining aircraft, will cut Air Force requirements in half.

Agile combat support involves not only “lean logistics,” but force protection as well because the transition to space operations will decrease the need for as many in-theater force protection assets.<sup>65</sup> However, fighting the war from the US homeland means that protection for the force may be required at home when the focus of the contingency operation is halfway around the world.<sup>66</sup> Especially important will be protection of satellite launch sites to ensure continued access to space. Equally significant will be the critical satellite uplink and downlink facilities through which the Air Force will execute space control and force application missions against enemy targets whether in space or on the earth. As combat operations increasingly are based from the United States and conducted in space, it is more important to defend US communications and intelligence gathering capabilities at home.

With these possibilities in mind, the mission of Air Force security units must evolve from the traditional concepts of air base defense to a more robust capability for rear area security. This will involve integration of Air Force security units with units from its sister services, as well as local, state, and national law enforcement agencies. Responsibilities will overlap, especially during peacetime and short duration contingency operations.

## **Rapid Global Mobility**

The concept of rapid global mobility is an essential element of the US ability to project power and sustain that power once it is deployed. Mobility assets move the personnel from all services and their materiel to the theater for the purpose of projecting force against the enemy. At first glance, it appears that the transition to warfare in space will only indirectly affect the Air Force core competency of rapid global mobility. As discussed earlier, the ability to conduct warfare from space will decrease the number of fighter and bomber squadrons that must be deployed to the theater of operations, and this in turn will reduce the demand on airlift because fewer forces will need to move to the theater. There will also be a proportional decline in replenishment by air and sea because it is no longer necessary to provide in-theater replenishment. One result is that joint military planners can shift airlift and sealift resources to support other missions. Another is that the decrease in airlift requirements will enable the Air Force to respond more rapidly to other types of missions, including humanitarian airlift, special operations, and support of Third World nations with available forces.

There is, however, a second view. Space operators working with airlift planners will provide the key to keeping global mobility viable in the next century. Security of overseas lines of communication is a center of gravity for the United States. Without the ability to project forces across the oceans, and to sustain that combat power once deployed, the United States will be unable to accomplish many of its military objectives. Space technologies which protect mobility assets during loading en route to the operational theater, and off-loading cargo at the

destination would prevent an enemy from attacking this US center of gravity. Modifications to sensor technologies might allow space assets to detect an impending attack against a mobility asset, and thereby preserve the concept of full-dimensional protection for space, airlift, and sealift assets.

## **Field Manual 100-20 Revisited: Command and Employment of Air and Space Power**

The core competencies addressed earlier provide a framework for viewing the changes the Air Force must make to adapt to the shift in warfare in, from, and through space. What is missing, however, is an overarching space doctrine to bridge the gap between these core competencies to develop, produce, deploy, and sustain these technologies. Looking again at the development of the Army Air Corps in World War II may provide some insights into the type of doctrine that the Air Force must employ for conducting military operations in space.

Following the Allied landings in North Africa in 1942, the US Army Air Corps had its first chance to support ground forces in the European theater. According to one observer, ground commanders “parceled out [US air power] to support specific ground units with mission priorities set by supported ground commanders. With a divided force, airmen were unable either to seize control of the air or to provide effective support for the ground forces in the face of centrally controlled and concentrated *Luftwaffe* resistance.”<sup>67</sup> To redress the “bitter experiences” of North Africa<sup>68</sup> the War Department issued Field Manual (FM) 100-20 on 21 July 1943.<sup>69</sup> This document gave air power an equal status with land power, and furthermore it centralized control of theater air operations under the command of airmen. It is appropriate to return to the concepts articulated in this seminal document as the foundation for future Air Force space doctrine.<sup>70</sup>

### **Relationship of Forces**

First, the fact is that land power, naval power, and aerospace power are coequal and interdependent types of military forces. With this fact in mind, the implication is that neither type of force is an auxiliary of any of the others. Each, therefore, must be viewed in terms of the totality of all the military forces that will be used by the United States to conduct military operations in, from, or through space.

### **Doctrine of Employment**

Second, gaining air, space, and information superiority is the first requirement for the success of any major military operation on the earth. While air and space forces may be properly and profitably employed against all forms of enemy military power, ground-based military forces operating without air and space superiority must take such extensive security measures against hostile air and space attack that it will reduce their mobility and ability to defeat enemy military forces on the earth. Therefore, air and space forces must be employed primarily against the enemy's air and space forces until air, space, and information superiority are obtained. Only then can destructive and demoralizing air and space attacks against surface forces be minimized, while the inherent maneuver and firepower of modern land, sea, and air forces are exploited to the fullest.

## **Command of Air and Space Power**

The greatest asset of air and space power is its inherent flexibility in view of its ability to concentrate military power in a short time. The use of aerospace power is a battle-winning factor of the highest order. If the United States is to fully exploit the inherent flexibility to deliver a decisive blow, control of available air and space power within the theater must be centralized, and command must be exercised through the joint force air component commander (JFACC), which should be “dual-hatted” as the joint force space component commander.<sup>72</sup> Therefore, the command of air, space, land, naval, marine, and special operations forces in a theater of operations will rest with the theater commander-in-chief (CINC), or designated to a joint task force commander. This commander will exercise command over air and space forces through the joint force air force component commander and command of ground forces through the land component commander.

These changes to the Air Force core competencies and doctrine offer one view of the future, but it is not important for the Air Force to accept this vision. It is important for the Air Force to develop a doctrine to guide the emergence of space warfare technologies. Given the development of critical technologies, it is time to develop both the doctrine and the technologies in concert so that the Air Force can match the strategy of applying military power from space to the strategic requirements the twenty-first century.

## IV. Conclusions and Recommendations

The intent of this study is to spark debate about the future of the United States Air Force as it begins the transition to military operations in space. Similar to the state of air power at the end of World War I, the Air Force is contemplating a vision of what space power can offer the nation in the coming decades if technology, doctrine, and strategy all advance.

Over the last four decades, the United States has become increasingly reliant on space, and so too has its military. The eyes and ears of the nation are now firmly rooted in space, which is exemplified by the fact that the military depends on satellites to support combat operations. As the United States becomes more reliant on space assets for its everyday existence, it becomes increasingly vulnerable to adversaries who, unlike Saddam Hussein during the Gulf War, will make every effort to destroy the eyes and ears of US military forces.

The vulnerability (whether perceived or real) of United States space assets and those of our allies will inevitably drive the United States to weaponize space. As in bygone eras, people who felt similar vulnerabilities to their homes, commerce, and way of life militarized the land, the sea, and the air. Now is the time for the nation and the Air Force to think through the strategy and technology that is required to support this transition. Many of the systems that the US will need to make this transition are technologically feasible, including space-based and ground-based lasers and kinetic energy weapons.

From a national perspective, the United States must overcome political, economic, and legal hurdles to make this shift toward military operations in space. The largest hurdles may be the inability of the Air Force to understand that its traditional means of employing air power with fighter and bomber aircraft are increasingly obsolete in technological and strategic terms. With these thoughts in mind, the Air Force must reassess its fundamental operational and doctrinal principles for the inevitable transition to military operations in space. To begin this transition, this study concludes that the Air Force should make the following changes:

First, it is time to establish the US Air Force Space Command as the Space Combat Command. This new name more accurately reflects the developing mission of this command and demonstrates to the Air Force, to the military, and to the American people the changing nature of military operations in space.

Second, it is necessary to energetically return to the roots of strategic air power doctrine. This will form the bridge between its core competencies and the process for developing new technologies. What the Air Force needs to aid the transition from an air force to a space force is an overarching strategy and coherent doctrine for space operations. By looking at its institutional past, the Air Force will find that it already has a strategy to guide this transition. However, it is only the means, not the ends, of air power theory that are changing. Whether using B-17s over Germany, F-117s over Baghdad, or ground-based lasers reflecting off space-based mirrors in the twenty-first century, the goal of air and space power remains to take the war to the heart of the enemy nation and attack its strategic center(s) of gravity without first having to fight through fielded ground forces. A by-product of this strategy is to isolate the battlefield and provide full-dimensional protection to national and allied resources at home and abroad.

Doctrinally, the Air Force is in a better position to make this transition than many may imagine. The newly announced core competencies, which form the basis of the transition, are as applicable to warfare in space as they are to warfare conducted with air-breathing assets. Air and

increasingly space superiority will remain a prerequisite for all other operations in the aerospace environment, and will form the basis for full-spectrum information superiority. Through space superiority, the US will take the initiative to protect its space assets and maintain greater freedom of action. Without air and space superiority, the US will yield the freedom of action to the enemy and thereby allow it to dictate the tempo of the war. The concept of global attack will expand to include the capability to attack any target on the face of the earth in a matter of minutes and to engage that target precisely, with selective, yet decisive force. The accompanying transition to military operations from the US homeland will increase the demand for agile combat support and full force protection at home. Finally, the decreasing need to deploy large numbers of fighter and bomber units will increase the ability of limited mobility assets to meet other transportation requirements.

Third, it is essential to vigorously pursue space weapons technologies such as ground-based and space-based lasers, radio frequency weapons, and kinetic energy weapons, among others, that will support the strategy of strategic bombardment in, from, and through space.

Fourth, it is imperative to integrate air and space operators in the development of both space doctrine and technology if the United States is to make the successful transition from air to space warfare. But those technologies will not meet the needs of the operational community unless operators have been involved in its development, testing, and deployment. Those who ultimately bear the responsibility for employing the forces in combat must share in the responsibility for the development of the appropriate employment doctrine.

Fifth, the benefit of integrating portions of the requirements directorates at “Space Combat Command” and Air Combat Command will ensure that exploring new concepts in the acquisition process will give equal consideration to both airborne and space borne alternatives to future military needs. This process should include the academic community on both the subject of the military in space and on the desired ends (as contrasted with the means) of the strategic bombardment mission in the new post-commissioning Aerospace Basic course that is conducted at Maxwell Air Force Base. Some of the lieutenants going through this course in the next five years will become the general officers who are charged with implementing the ultimate change from an air to a space force when these technologies mature in thirty years.

Sixth, Air Force leaders must pave the way for the nation and the Air Force to understand the need for this transition. This study concludes with a haunting question for the United States Air Force: Can the Air Force make the internal changes necessary to permit the strategic application of air power from and through space if it means relinquishing fighter and bomber aviation in the process?

## Afterword

This research has given me an opportunity to think about the development of the Air Force and the changes that must take place to ensure that the United States retains its technological superiority and combat edge in the twenty-first century.

One of the questions many have asked as they have reviewed this study is whether I am advocating a separate space force to execute the doctrine outlined in this paper. I have attempted to leave this emotionally charged issue out of my paper, but feel it deserves comment. At this time, my answer is no.

Advocates of a separate space force state that the same arguments made by air power advocates in the 1930s and 1940s with respect to a separate air force are true today when applied to the separation of a space force from the Air Force. In many cases this is true.

However, what has not changed as a result of conducting warfare in, from, and through space is the mission. The vision of air power has always been to use the third dimension to take the war to the enemy's strategic center(s) of gravity, to destroy its capability or will to wage war, without first having to fight through fielded forces. This was a different vision and mission from that of the Army in the 1930s and remains so today. What we see as space forces in the next 50 years will give the United States a new means to perform this mission that will be more effective, responsive, and will do so at less cost and with lower risk of human life. But it does not change the basic nature of the mission. Just as naval forces currently operate on, above, and under the surface of the water to control sea lanes and project power ashore, air forces will soon project power from the media of air and space.

In the future, new missions for space forces may emerge that provide a vision separate from that of air forces when space forces turn their attention away from the surface of the earth. When that time comes, the U.S. Air Force needs to be foremost among those who demand the creation of a new and independent space force. To do otherwise would show the lack of vision that would place Air Force leaders in the same position as Army leaders of the 1930s, who were more interested in the sanctity of the organization than in providing the most effective combat power for the United States.

## **Glossary**

AFM Air Force Manual  
ASAT Antisatellite  
AU Air University  
AWC Air War College  
CAS Close Air Support  
CINC Commander-In-Chief  
CONUS Continental United States  
DSP Defense Support Program  
DMSP Defense Meteorological Support Program  
DSCS Defense Satellite Communications System  
FM Field Manual  
GPS Global Positioning System  
JFACC Joint Force Air Component Commander  
SPOT System Probatoire d'Observation de la Terre  
USAF United States Air Force  
USCINCSpace Commander-In-Chief, United States Space Command  
USSPACECOM United States Space Command

## Notes

1. Larry H. Addington, *The Patterns of War Since the Eighteenth Century* (Bloomington, IN: Indiana University Press, 1984), 157.
2. Lee Kennett, *The First Air War: 1914-1918* (New York: The Free Press, 1991), 217. "To them it appeared as an auxiliary, preparing and supporting the main action without itself being center stage."
3. *Ibid.*, p. 221.
4. *Ibid.*, p. 218.
5. *Ibid.*, p. 221.
6. *Ibid.*, p. 221.
7. Richard P. Hallion, *Storm over Iraq* (Washington, DC: Smithsonian Institution Press, 1992), p. 239.
8. Thomas A. Keaney and Elliot A. Cohen, *The Gulf War Air Power Survey Summary Report* (Washington, DC: U.S. Government Printing Office, 1993), p. 194.
9. Hallion, p. 314.
10. Peter Anson and Dennis Cummings, "The First Space War: The Contribution of Satellites to the Gulf War," in Alan D. Campen (ed.), *The First Information War* (Fairfax, VA: AFCEA International Press, October 1992), p. 127.
11. Hallion, p. 314.
12. Keany and Cohen, p.194.
13. See Frederick W. Kagan, "Star Wars in Real Life: Political Limitation on Space Warfare," *Parameters*, Autumn 1998, pp. 112-20.
14. The term "weaponize space" means to employ weapons in, through, or from space.
15. These impediments are discussed in Michael J. Muolo, *Space Handbook: A Warfighter's Guide to Space, Volume One* (Maxwell Air Force Base: Air University Press, 1993), pp. 1-47.
16. USAF Scientific Advisory Board, "Summary Volume," *New World Vistas: Air and Space Power for the 21st Century. Report to the USAF Chief of Staff* (Washington, DC: Government Printing Office, December 1995).
17. *Contrails: The Air Force Cadet Handbook*, Vol 20 (USAF Academy, Colorado, 1974), p. 14.
18. *Ibid.*, p. 16.
19. *Ibid.*, p. 17.
20. This term is used extensively in David E Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell Air Force Base, Alabama: Air University Press, 1988).
21. General Howell M. Estes, Commander, US Space Command, Address to the Air Force Association Annual Symposium, Los Angeles, CA, October 18, 1996.
22. See briefing by USAF Long-Range Plans Division on *Global Engagement: A Vision for the 21st Century Air Force* (Washington, DC: U.S. Air Force, 1996). For reference, see [www.af-future.hq.af.mil/21/index.htm](http://www.af-future.hq.af.mil/21/index.htm), p. 6.
23. See Estes Speech.
24. See briefing by USAF Long-Range Plans Division on *Global Engagement* p. 6.
25. See Estes Speech.
26. Perry M. Smith, *Taking Charge: A Practical Guide for Leaders* (Washington, DC: National Defense University Press, 1986), p. 121.

27. *Ibid.*, p. 121.
28. The author wishes to thank Carl Builder of The RAND Corporation, for his inspiration in this area. His book *The Icarus Syndrome*, helped put the ends and the means of air power, and by extension space power, into focus.
29. The White House. *A National Security Strategy of Engagement and Enlargement* (Washington, DC: February 1996), p. ii.
30. General Ronald R. Fogleman, Address on “Global Engagement” (Washington, DC: Smithsonian Institution, November 21 1996). For reference, see [www.dtic.mil/airforcelink/pa/speech/current/Global\\_Engagement.html](http://www.dtic.mil/airforcelink/pa/speech/current/Global_Engagement.html).
31. US Air Force Long Range Plans Division, *Global Engagement: A Vision for the 21st Century Air Force*. Briefing, 12 November 1996. For reference, see <http://www.af-future.hq.af.mil/21/index.htm>.
32. *Joint Vision 2010. America's Military: Preparing for Tomorrow* (Washington, DC: Office of the Chairman, Joint Chiefs of Staff, 1996), p. 1.
33. US Department of the Air Force. “Investing in Future Technologies.” Air Force Policy Letter Digest, June 1996. For reference, see <http://www.dtic.mil/airforcelink/pubs/policy/letters/pl96-06.html>.
34. US Department of the Air Force. *Aerospace Power for the 21st Century: A Theory to Fly By—A White Paper from the Strategic Aerospace Warfare Study Panel* (Maxwell Air Force Base Alabama, 4 October 1996), p. 7.
35. *Ibid.*, p. v.
36. *Ibid.*, p. 11.
37. Joint Publication 0-2, *Unified Action Armed Forces* (UNAAF), (Washington, DC: Government Printing Office, 24 February 1995), p. GL-5.
38. US Air Force Long Range Plans Division. *Global Engagement: A Vision for the 21st Century Air Force*, pp. 6,7.
39. James G. Lee, *Counterspace Operations for Information Dominance*. (Maxwell Air Force Base, AL: Air University Press, 1994), p. 19. In this seminal paper, Lee recognizes that “proliferating space capabilities could provide regional powers with an advantage over US forces in any future regional conflict . . . by eliminating the US ability to achieve strategic and tactical surprise. The inability of US forces to achieve surprise could lead to protracted engagements.”
40. *Ibid.*, p. 27.
41. Haywood S. Hansell, Jr., *The Air Campaign that Defeated Hitler* (Atlanta: Higgins-McArthur/Logino & Porter, Inc, 1972), p. 15.
42. David MacIsaac, *Strategic Bombing in World War II* (New York: Garland Publishing, Inc., 1976), p. 7.
43. Victor B. Anthony, “The Combined Bomber Offensive in Europe” in *History 202: Modern Warfare and Society* (Colorado Springs, CO: Department of History, United States Air Force Academy, 1976), pp. 30-33.
44. B. H. Liddell Hart, *History of the Second World War*, (New York: G.P. Putnam's Sons, 1971), p. 591.
45. See Michael R. Mantz, *The New Sword: A Theory of Space Combat Power*, (Maxwell Air Force Base, AL: Air University Press, 1995), pp. 36-46, who notes that these space control missions may take the form of earth-to-earth or space-to earth attacks against space launch or space control systems as well as earth-to-space or space-to-space attacks against space-deployed platforms.

46. USAF Scientific Advisory Board. "Space Technology Volume." *New World Vistas: Air and Space Power for the 21st Century*. Report to the USAF Chief of Staff. (Washington, DC: Government Printing Office, December 1995), p. iii.
47. *Ibid.*, p. 8.
48. *Ibid.*, p. ix.
49. *Ibid.*, p. ix.
50. The protection of ground segments of space systems is discussed later in this study.
51. USAF Scientific Advisory Board. "Space Applications Volume." *New World Vistas: Air and Space Power for the 21st Century*, pp. xvii, xxii, 76, 115, 117.
52. USAF Scientific Advisory Board, p. ix.
53. *Ibid.*, p. ix.
54. See Mantz, *The New Sword*, p. 46, for some ideas on possible target sets.
55. USAF Scientific Advisory Board. *Summary Volume, New World Vistas: Air and Space Power for the 21st Century*, p. 40.
56. USAF Scientific Advisory Board, *Space Applications Volume*, p. xxii.
57. *Ibid.*, p. xxii.
58. *Ibid.*, p. 83.
59. USAF Scientific Advisory Board, *Directed Energy Volume*, p. v.
60. *Ibid.*, p. vii.
61. See Scott M. Britten, *Reachback Operations for Air Campaign Planning and Execution* (Maxwell AFB: Air War College, Center for Strategy and Technology, Occasional Paper No. 1, 1997).
62. USAF Scientific Advisory Board, *Directed Energy Volume*, p. xiii.
63. *Ibid.*, p. xiii.
64. See *Global Engagement: A Vision for the 21st Century Air Force*.
65. See *Global Engagement*.
66. See Mantz, pp. 49-56.
67. Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force*, Vol. 2, March, 1992, p. 113.
68. *Ibid.*, p. 113.
69. War Department Field Manual 100-20, *Command and Employment of Air Power*, 21 July 1943.
70. AFM 1-1, Vol. 2, p. 122.
71. The reader will note that the headings and text of the next three sections are taken in large part from the 21 Jul 1943 edition of FM 100-20, *Command and Employment of Airpower* and are modified with appropriate references to emerging space doctrine.
72. It is important to maintain control of air and space assets in the theater as well as on a global basis. The possibility exists that space assets will concurrently support operations in more than one theater. Just as the JFACC currently coordinates out-of-theater long-range bomber aircraft with the owning command (e.g., Air Combat Command through US Atlantic Command), that commander also will task USSPACECOM as a supporting CINC when theater missions require satellites for air defense or to kill targets on the earth. This will be accomplished through the Air Tasking Order process.

## Bibliography

- Addington, Larry H. *The Patterns of War Since the Eighteenth Century*. Bloomington, Indiana: Indiana University Press, 1984.
- Air Force Manual (AFM) 1-1. *Basic Aerospace Doctrine of the United States Air Force*. 2 vols., March 1992.
- "Air Force Modifies Core Competencies." *Air Force News Service*. 24 October 96.
- Anson, Sir Peter and Cummings, Dennis. "The First Space War: The Contribution of Satellites to the Gulf War," in *The First Information War*, ed. Alan D. Campen. Fairfax, VA: AFCEA International Press, October 1992.
- Anthony, Major Victor B. "The Combined Bomber Offensive in Europe." In *History 202: Modern Warfare and Society*. Edited by the Staff of the Department of History, United States Air Force Academy. USAF Academy, Colorado, 1976.
- Baker, David. *The Shape of Wars to Come*. Briarcliff Manor, N.Y.: Stein & Day., 1982.
- Bellamy, Ian. "Controlling Military Activities in Space." In *The Militarisation of Space*. Edited by Stephen Kirby and Gordon Robson. Sussex, England: Wheatsheaf Books, 1987.
- Brown, Neville. *New Strategy Through Space*. Leicester, England: Leicester University Press, 1990.
- Builder, Carl H. "Doctrinal Frontiers." *Airpower Journal*. Winter 1995, 6-13. Reprinted in Air War College Academic Year 1997 Department of Strategy, Doctrine, and Air Power Readings: Volume III, pp. 602-609.
- Builder, Carl H. *The Icarus Syndrome: The Role of Air Power Theory in the Evolution and Fate of the U. S. Air Force*. New Brunswick, USA: Transaction Publishers, 1994.
- Carnes, General Michael P. C., "A Commentary," Address. National Security Industrial Association Symposium, 10 November 1994; on-line, Internet, 26 November 1996, available from <http://www.cdsar.af.mil/apj/carnes.html>.
- Contrails: *The Air Force Cadet Handbook*. Volume 20. USAF Academy, Colorado, 1974.
- Correll, John T. "The Rediscovery of Strategic Airpower." *Air Force Magazine*. November 1996, 26-32.
- Estes, Gen Howell M. IV. Commander, US Space Command. Address. Air Force Association Annual Symposium, Los Angeles, CA, 18 October 1996; on-line, Internet, 30 November 1996, available from <http://www.spacecom.af.mil/hqafspc/contents/library/speeches/18Oct96.html>.
- Fogleman, General Ronald R. USAF Chief of Staff, "Global Engagement," Address. Smithsonian Institution, Washington, DC, 21 November 1996; on-line, Internet, 30 November 1996, available from [http://www.dtic.mil/airforcelink/pa/speech/current/Global\\_Engagement.html](http://www.dtic.mil/airforcelink/pa/speech/current/Global_Engagement.html).
- "Global Engagement: A Vision for the 21st Century Air Force." Slides and Notes. 12 November 1996; available through Air War College Local Area Network, 26 November 1996.
- Graham, Daniel O. "Space Policy 2000 Double Prime." *The Journal of Practical Applications in Space*. Summer 1994.
- Hallion, Dr. Richard P. *Storm over Iraq*. Washington: Smithsonian Institute Press, 1992.
- Hansell, Major General Haywood, S. *The Air Campaign that Defeated Hitler*. Atlanta: Higgins-McArthur/Longino & Porter, Inc., 1972.

Hart, Sir B. H. Liddell, *History of the Second World War*. New York: G. P. Putnam's Sons, 1971.

"History," n.p.; on-line, Internet, 2 January 1997, available from <http://www.spacecom.af.mil/usspace/history.htm>.

Joint Publication 0-2, *Unified Action Armed Forces (UNAAF)*, 24 February 1995).

Keaney, Thomas A. and Cohen, Elliot A., *The Gulf War Air Power Survey Summary Report*. Washington: U.S. Government Printing Office, 1993.

Kennett, Lee. *The First Air War: 1914-1918*. New York: The Free Press, 1991.

Kirby, Stephen. "Inevitability and Choice in the Militarisation of Space." In *The Militarisation of Space*. Edited by Stephen Kirby and Gordon Robson. Sussex, England: Wheatsheaf Books, 1987.

Lambeth, Benjamin S. "Technology and Air War." *Air Force Magazine*. November 1996, 50-53.

Lee, Major James G. *Counterspace Operations for Information Dominance*. Maxwell Air Force Base, AL: Air University Press, 1994.

Lupton, Lt Col David E. *On Space Warfare: A Space Power Doctrine*. Maxwell Air Force Base, AL: Air University Press, 1988.

McKinley, Major Cynthia A. S. "United States Strategy and Policy." Slides from HQ Air Force Space Command Strategy and Policy Briefing, January 1996.

MacIsaac, David. *Strategic Bombing in World War II*. New York: Garland Publishing, Inc., 1976.

Mantz, Lt Col Michael R. *The New Sword: A Theory of Space Combat Power*. Maxwell Air Force Base, AL: Air University Press, 1995.

Moore, Captain George M. (USN) ; Budura, Colonel Vic (USAF); and Johnson-Freese, Dr. Joan. "Joint Space Doctrine: Catapulting Into the Future." *Joint Forces Quarterly*. Summer 1994, 71-76. Reprinted in Air War College Academic Year 1997 Department of Strategy, Doctrine, and Air Power Readings: Volume III, pp. 549-554.

Moorman, Gen Thomas S. Jr. USAF Vice Chief of Staff. "The Challenges of Space Beyond 2000," Address. 75th Royal Australian Air Force Anniversary Airpower Conference, Canberra, Australia, 14 June 1996; on-line, Internet, 30 November 1996, available from [http://www.dtic.mil/airforcelink/pa/speech/current/The\\_Challenge\\_of\\_Space\\_Bey.html](http://www.dtic.mil/airforcelink/pa/speech/current/The_Challenge_of_Space_Bey.html).

Muolo, Major Michael J. *Space Handbook: A Warfighter's Guide to Space, Volume I*. Maxwell AFB, AL: Air University Press, 1993.

Myers, Colonel Kenneth A. (USAF) and Tockston, Lt Col John G. (USAF). "Real Tenets of Military Space Doctrine." *Airpower Journal*. Winter 1988, 54-68. Reprinted in Air War College Academic Year 1997 Department of Strategy, Doctrine, and Air Power Readings: Volume III, pp. 509-523.

Rankine, Major General Robert R. Jr., "The US Military Is Not Lost in Space." In *Building A Consensus Toward Space: Proceeding of the 1988 Space Issues Symposium*. Center for Aerospace Doctrine, Research, and Education. Maxwell AFB, AL: Air University Press, April 1990, pp. 47-60.

Rhineland, John B. "The Law and Space." In *Building A Consensus Toward Space: Proceeding of the 1988 Space Issues Symposium*. Center for Aerospace Doctrine, Research, and Education. Maxwell AFB, AL: Air University Press, April 1990, 3-12.

Robson, Gordon. "Introduction: States, Space, and Security." In *The Militarisation of Space*. Edited by Stephen Kirby and Gordon Robson. Sussex, England: Wheatsheaf Books, 1987.

Robson, Gordon. "The Strategic Context of Space." In *The Militarisation of Space*. Edited by Stephen Kirby and Gordon Robson. Sussex, England: Wheatsheaf Books, 1987.

Rosenberg, Major General Robert A. USAF Retired. *"Building A Consensus toward Space Doctrine."* In *Building A Consensus Toward Space: Proceeding of the 1988 Space Issues Symposium*. Center for Aerospace Doctrine, Research, and Education. Maxwell AFB, AL: Air University Press, April 1990, pp. 115-124.

Shalikashvili, General John M. "Joint Vision 2010." Washington DC: Office of the Chairman, Joint Chiefs of Staff, 1996.

Shalikashvili, General John M. "National Military Strategy of the United States of America: A Strategy of Flexible and Selective Engagement." Washington DC: Office of the Chairman, Joint Chiefs of Staff, 1995.

Shepherd, Lt Colonel Dennis. "Outer Space and Military Space Doctrine." *Law/technology*, volume 28, no. 2 (2nd Quarter 1995), 1 - 10.

Shepherd, Lt Colonel Dennis. "Space Law As A Core Area For The Air Force Judge Advocate." *The Reporter*, volume 20, no 5, 3.

Shepherd, Lt Colonel Dennis. "Summary of International Law; Air and Space Law," class notes of the author from lecture to Military Commander and the Law academic session, Air War College, Maxwell Air Force Base, AL, 16 August 1996.

Shulman, Seth "Code Name: Corona," *Technology Review*, 24 October 1996, 23-32.

Smith, Major General (Retired) Perry M., *Taking Charge: A Practical Guide for Leaders* Washington: National Defense University Press, 1986.

Snyder, William P. "An Introduction to the Peloponnesian War." Reprinted in Air War College Associate Programs, Vol 1, Lesson 1, 4th Edition, Maxwell AFB, Alabama: Air University Press, 1983.

"Spacecast 2020." Maxwell AFB, AL: Air University Press, 1995. Reprinted in Air War College Academic Year 1997 Department of Strategy, Doctrine, and Air Power Readings: Volume III, 555-582.

Thucydides. *The Peloponnesian War*, Translated by Benjamin Jowett. Reprinted in Air War College Associate Programs, Vol 1, Lesson 1, 4th Edition, Maxwell AFB, Alabama: Air University Press, 1983.

"Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies," 25 April 1967, n.p.; on-line, Internet, 2 January 1997, available from <http://www.acda.gov/treaties/space1.htm>. (Text of treaty itself can be found at <http://www.acda.gov/treaties/space2.htm>).

US Air Force Long Range Plans Division. "Global Engagement: A Vision for the 21st Century Air Force." Briefing Script. 12 November 1996; on line, Internet, 26 November 1996, available from <http://www.af-future.hq.af.mil/21/index.htm>.

USAF Scientific Advisory Board. "Directed Energy Volume." *New World Vistas: Air and Space Power for the 21st Century*. Report to the USAF Chief of Staff. Washington, DC: Government Printing Office, December 1995.

USAF Scientific Advisory Board. "Space Applications Volume." *New World Vistas: Air and Space Power for the 21st Century*. Report to the USAF Chief of Staff. Washington, DC: Government Printing Office, December 1995.

USAF Scientific Advisory Board. "Space Technology Volume." *New World Vistas: Air and Space Power for the 21st Century*. Report to the USAF Chief of Staff. Washington, DC: Government Printing Office, December 1995.

USAF Scientific Advisory Board. "Summary Volume." *New World Vistas: Air and Space Power for the 21st Century*. Report to the USAF Chief of Staff. Washington, DC: Government Printing Office, December 1995.

US Department of the Air Force. "A New American Way of War." *Air Force Policy Letter Digest*, April 1996; on-line, Internet, 26 November 1996, available from <http://www.dtic.mil/airforcelink/pubs/policy/letters/pl96-04.html>.

US Department of the Air Force. "Aerospace Doctrine—More Than Just A Theory." *Air Force Policy Letter Digest*, June 1996; on-line, Internet, 26 November 1996, available from <http://www.dtic.mil/airforcelink/pubs/policy/letters/pl96-06.html>.

US Department of the Air Force. *Aerospace Power for the 21st Century: A Theory to Fly By—A White Paper from the Strategic Aerospace Warfare Study Panel*. Maxwell Air Force Base Alabama, 4 October 1996.

US Department of the Air Force. *Fact Sheet: YAL-1A Attack Laser*. Kirtland Air Force Base NM.: Office of Public Affairs, Phillips Laboratory, 12 November 1996.

US Department of the Air Force. "Investing in Future Technologies." *Air Force Policy Letter Digest*, June 1996; on-line, Internet, 26 November 1996, available from <http://www.dtic.mil/airforcelink/pubs/policy/letters/pl96-06.html>.

Vessey, General John W. Jr., "1996 Thayer Award Acceptance Remarks," *Assembly*, January/February 1997, 22-26.

War Department Field Manual (FM) 100-20. *Command and Employment of Air Power*. 21 July 1943.

Weigley, Russell F. *The American Way of War: A History of United States Military Strategy and Policy*. Bloomington, Indiana: Indiana University Press, 1977.

Weinberger, Caspar W., *Fighting for Peace: Seven Critical Years in the Pentagon* New York: Warner Books, 1990.

Widnall, The Honorable Sheila E. Secretary of the Air Force, "Adapting to an Altered Strategic Environment," Address. Center for Strategic and International Studies, Washington, DC, 25 November 1996; on-line, Internet, 30 November 1996, available from [http://www.dtic.mil/airforcelink/pa/speech/current/Adapting\\_To\\_An\\_Altered\\_Strategic\\_Environment.htm](http://www.dtic.mil/airforcelink/pa/speech/current/Adapting_To_An_Altered_Strategic_Environment.htm).

The White House. "A National Security Strategy of Engagement and Enlargement.," February 1996.

The White House. *Fact Sheet: National Space Policy*. National Science and Technology Council, 19 September 1996.

## **Center for Strategy and Technology**

The Center for Strategy and Technology was established at the Air War College in 1996. Its purpose is to engage in long-term strategic thinking about technology and its implications for U.S. national security.

The Center focuses on education, research, and publications that support the integration of technology into national strategy and policy. Its charter is to support faculty and student research, publish research through books, articles, and occasional papers, fund a regular program of guest speakers, host conferences and symposia on these issues, and engage in collaborative research with U.S. and international academic institutions. As an outside funded activity, the Center enjoys the support of institutions in the strategic, scientific, and technological worlds. Principal funding is provided by the Air Force Research Laboratory (AFRL), with additional support from the Defense Advanced Research Projects Agency (DARPA).

An essential part of this program is to establish relationships with organizations in the Air Force as well as other Defense of Department agencies, and identify potential topics for research projects. Research conducted under the auspices of the Center is published as Occasional Papers and disseminated to senior military and political officials, think tanks, educational institutions, and other interested parties. Through these publications, the Center hopes to promote the integration of technology and strategy in support of U.S. national security objectives.

For further information on the Center on Strategy and Technology, please contact:

William C. Martel, Director  
Air War College  
325 Chennault Circle  
Maxwell AFB  
Montgomery, AL 36112  
(334) 953-2384 (DSN 493-2384)  
Email: [wmartel@max1.au.af.mil](mailto:wmartel@max1.au.af.mil)

The Occasional Papers series was established by the Center for Strategy and Technology as a forum for research on topics that reflect long-term strategic thinking about technology and its implications for U. S. national security.

**Center for Strategy and Technology  
Air War College**

**Maxwell Air Force Base  
Montgomery, Al 36112**